July 16, 1935. W. Y. LEWIS 2,008,076

HEAT TRANSFER DEVICE

Filed July 7, 1932 4 Sheets-Sheet 1

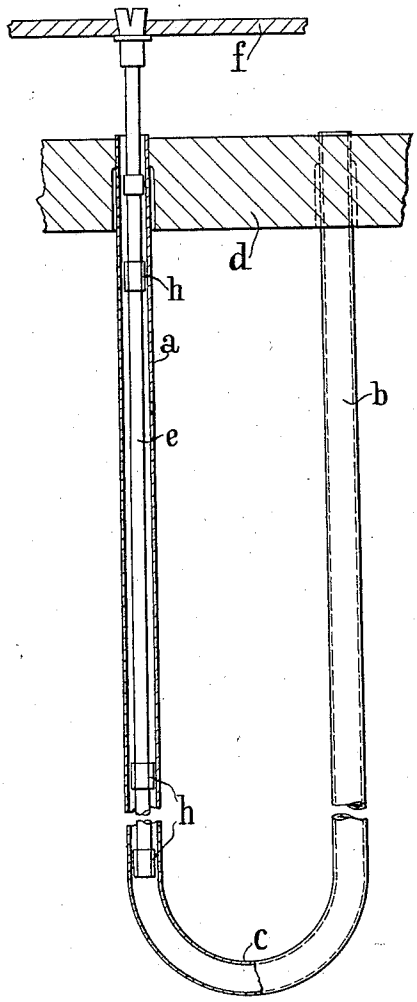


Fig.1.

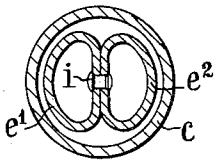


Fig.4.

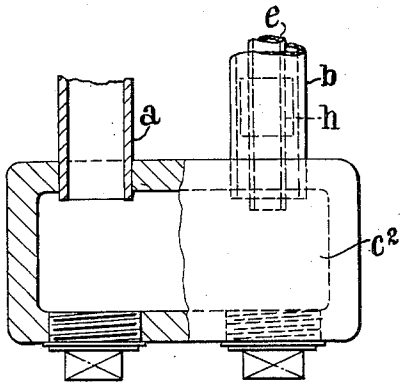


Fig.7.

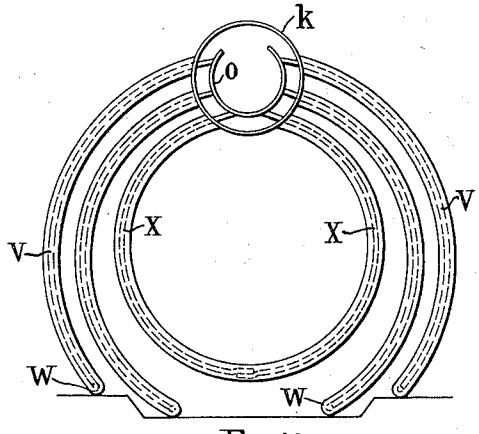


Fig.10.

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HEAT TRANSFER DEVICE

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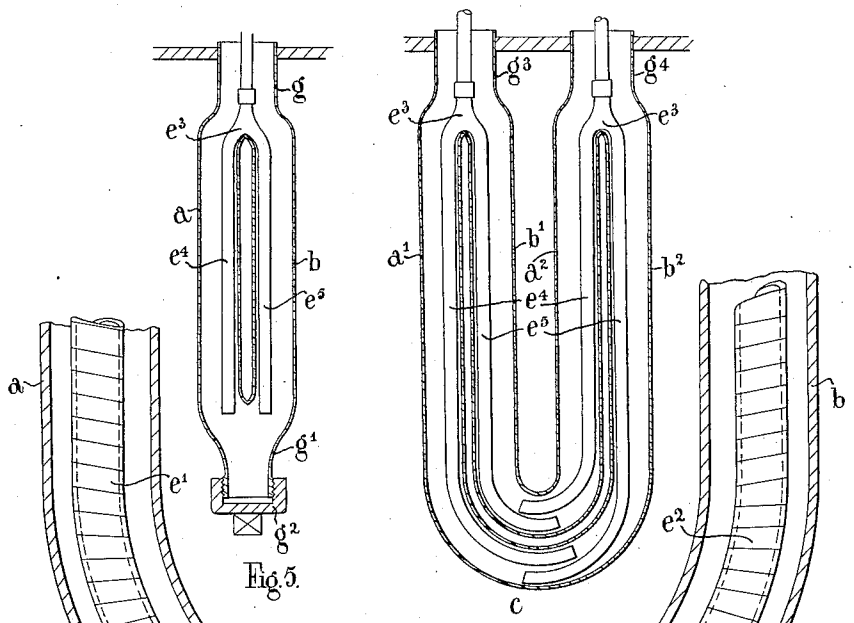


Fig.5.

Fig.6.

Fig.2.

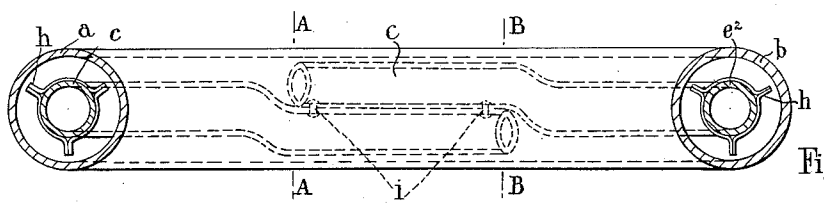


Fig.3.

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HEAT TRANSFER DEVICE

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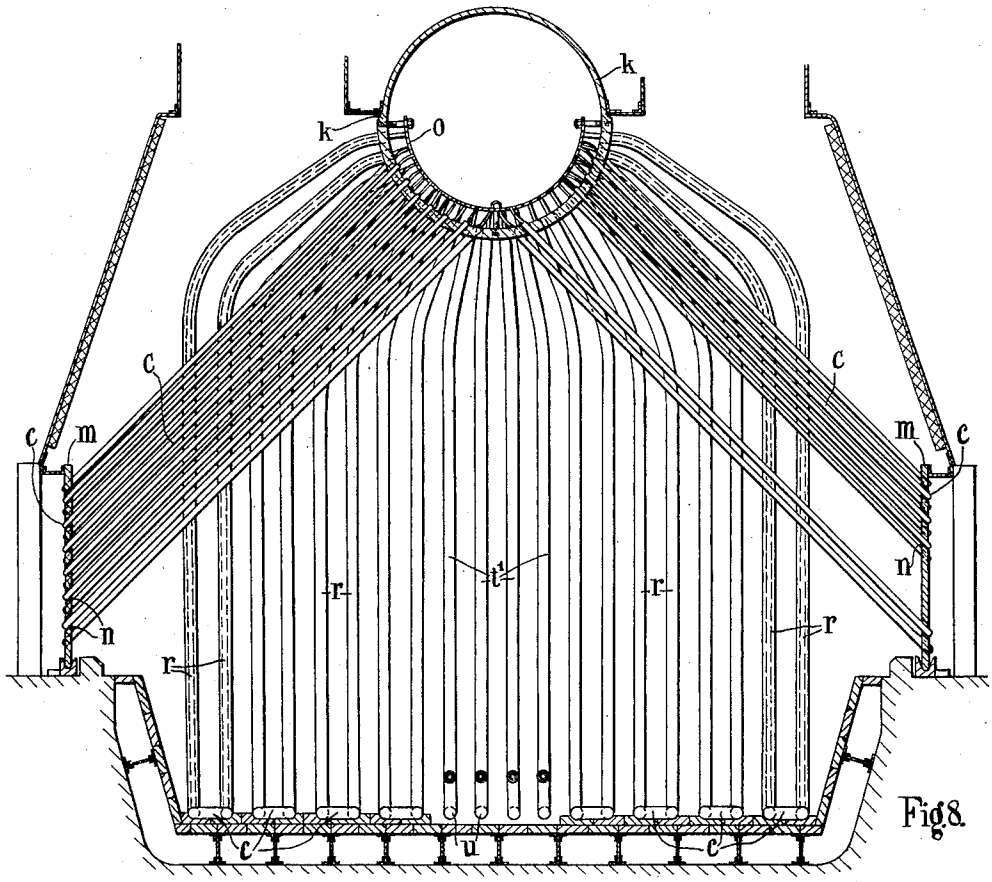


Fig.8.

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HEAT TRANSFER DEVICE

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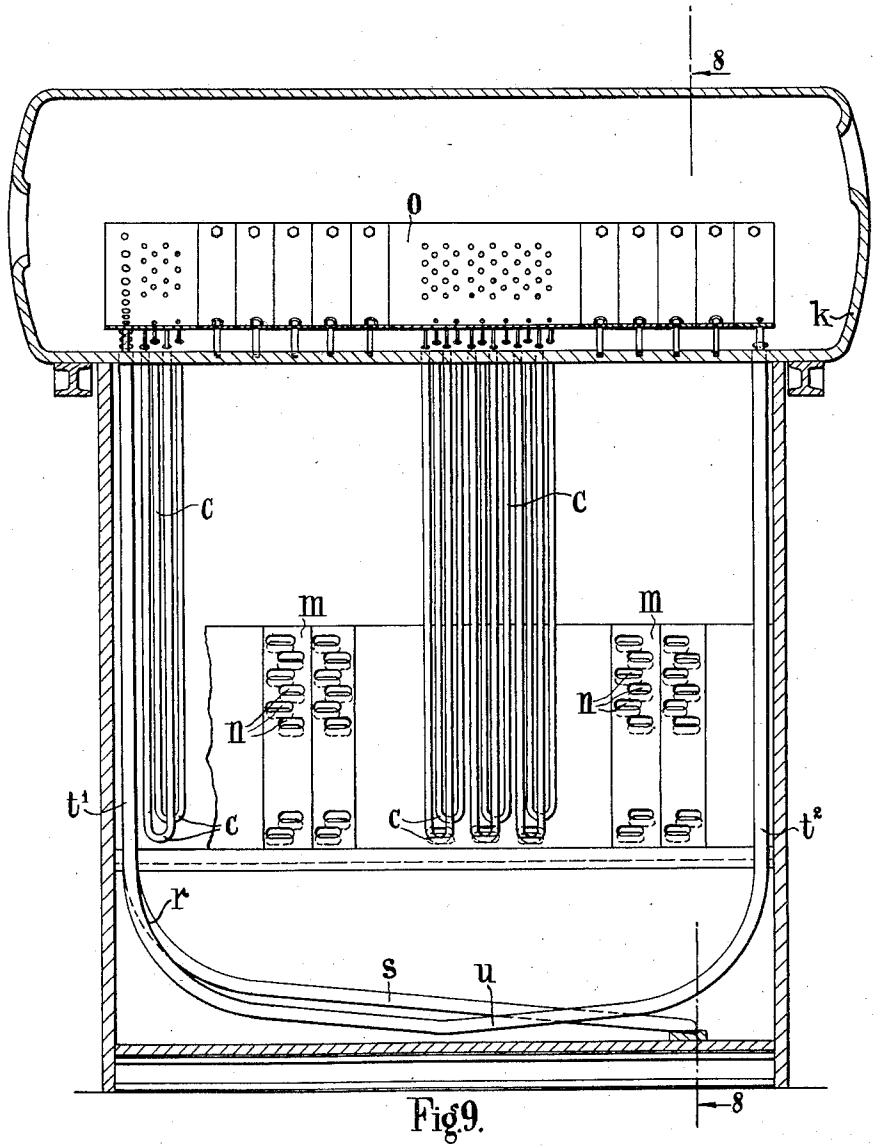


Fig. 9.

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Patented July 16, 1935 2,008,076

UNITED STATES PATENT OFFICE

2,008,076

HEAT TRANSFER DEVICE

William Yorath Lewis, London, England

Application July 7, 1932, Serial No. 621,250
In Great Britain July 20, 1931

5 Claims. (Cl. 122—282)

The invention relates to heat-transfer devices particularly suitable for water-tube boilers.

A main object of the present invention is to provide practicable forms of water-tube boiler, suitable in particular for modern high pressures, and of reduced weight and cost of manufacture in comparison with the present boilers they are intended to replace.

With such a main object, the present invention consists in the improved forms of U-Field-tube water-tube boiler and in certain novel forms of U-Field-tube unit applicable in such boilers as hereinafter described and defined in the claims appendant hereto.

In order to make clear the nature and operation of the present invention, I propose first to describe by way of example certain forms of U-Field-tube unit suitable for the purposes of the present invention and subsequently to describe practicable forms of high-pressure U-Field-tube water-tube boilers.

Referring with this object to the accompanying drawings, which are of a diagrammatic nature:—

Figure 1 shows a sectional elevation of a form of U-Field-tube unit according to the present invention with an inner tube in one leg;

Figure 2 shows a sectional elevation of another form of U-Field-tube unit having a flexible inner tube inserted in each leg, the inner tubes overlapping within the bend,

Figure 3 being a corresponding plan, and

Figure 4 a cross-section on the line 4—4 of Figure 2;

Figure 5 shows a sectional elevation of a modified form in which the two legs of the U are united at their upper ends,

Figure 6 being a similar view of yet another form in which a plurality of U's are connected at corresponding ends in common junction-pieces;

Figure 7 shows a sectional elevation of an equivalent form of U-Field-tube unit in which the bend of the U is replaced by a junction box;

Figure 8 shows an end elevation taken on the line 8—8 of Figure 9 of a modified Yarrow-type water-tube boiler embodying U-Field-tube units,

Figure 9 being a corresponding side view; and

Figure 10 shows a sketch of a modification of the Johnson type of water-tube boiler including U-Field-tube units in its structure.

Where desirable the same reference symbols are used in the different figures to denote corresponding parts.

Referring to Figure 1, the U-Field-tube unit shown therein consists of two parallel legs *a*. *b*. interconnected by a bend, *c*, to form a U-tube, the open ends of which are secured by any suitable means to a wall, *d*, of a suitable receptacle or container, and an inner tube, *e*, arranged within one of the U-legs, say *a*, this inner tube being open at both ends and passing along the length of its U-leg, *a*, to the beginning of the bend or thereabouts, the upper end being secured to a second wall, *f*, or otherwise terminated or fixed in any suitable manner.

In some cases, an inner tube may be provided in each leg of the U.

The inner tube, *e*, may be centralized in its leg, *a*, by suitable devices such as the fins *h*.

According to a modified form of U-Field-tube unit (see Figures 2, 3 and 4) the outer tube comprises the straight legs, *a* and *b*, united by the bend, *c*, and an inner tube, e^1, e^2, inserted in each leg, the ends of these inner tubes being in some cases flexible as indicated in Figure 2 and overlapping over a length, A—B, preferably disposed centrally at the bottom of the bend, *c*. To provide for the overlap, which may extend even right round the bend, the ends of the inner tubes are in some cases offset as shown in Figure 3, while if desired they may in addition be given a D-shape in cross-section as shown in Figure 4, the juxtaposed flats of the D's being secured by rivets, *i*, *i*, or other suitable means, such as a binder.

According to another form of U-Field-tube unit (see Figure 5) the two legs, *a*, *b*, are connected at their upper ends in the common junction-piece, *g*, for expansion into the wall of a suitable container, the inner tube, e^3, being forked as shown and the two branches, e^4, e^5, passing down the respective legs of the U. In this case, the inner tubes, e^4, e^5, are conveniently positioned eccentrically in their outer tubes and held in place by the interaction of the inner and outer forks.

When the two legs, *a*, *b*, of the U are arranged close together as in Figure 5, the turn of the U may take the form of a spear-head bend, well known as applied to superheater elements, or as shown in Figure 5, the lower ends of the U-legs may be connected by a junction-piece, g^1, similar to that connecting the upper ends, but modified by the provision of a screwed cap, g^2, removable for cleaning or inspection purposes.

Or again, two U's with legs a^1, b^1, and a^2, b^2, arranged, e. g., one within the other, as shown in Figure 6, or alternatively side by side, are connected at their corresponding upper ends in the

common junction-pieces, g^3, g^4, the inner tubes e^3, e^3, being forked as in Figure 5 to form branches, e^4, e^5.

The structural details of a U-Field-tube unit in accordance with the present invention may be modified as required to meet the conditions of its particular application.

Thus, the inner tube, instead of being rigid may be flexible or partly rigid and partly flexible, or it may be constructed in a single length or of a series of detachable lengths, particularly with a view to obtaining ready access to the mouth of the outer tube for the application and operation of suitable expanding tools.

Further, in certain applications of the invention, as exemplified below, one or more legs of the device, instead of being straight, may be curved so as to provide, e. g., a water-tube wall of any desired contour; in other cases, U-legs arranged at any desired angle may be substituted for the parallel legs described.

When the inner tube is rigid, it may be inserted into the outer tube, and bent simultaneously therewith to form a complete unit ready for assembly.

In some cases, the interconnection between the legs of a U, may take the form of a junction box, c^2, (see Figure 7) serving as the equivalent of the U bend.

If desired, in some applications, suitable draining arrangements may be provided at the point or region of interconnection of the legs or a short length of tube projecting from the bend of the U may be provided as a mud-box or sump, its end being closed solid or by a removable cap or plug; if the end is closed, it may be sawn off for inspection purposes, cleaning or the like and re-closed, e. g., by welding.

The inner tubes may be positioned in any suitable manner as, e. g., by suitable distance pieces within the outer tubes, from which they project somewhat, or their projecting ends may be secured to one or more plates forming a partition or diaphragm of a receptacle or container as above mentioned.

Turning now to the specific application of a U-Field-tube unit in accordance with the invention, for example, to one form of the well-known high-pressure Yarrow water-tube boiler (see Figures 8 and 9) a steam-and-water drum, k, is provided and depending at a considerable angle to the horizontal therefrom on each side of the furnace, one or more banks, C, C, of closely-spaced U-Field-tube units of a length considerably greater than the diameter of the steam-and-water drum; the planes of the U's in the example shown are parallel to the axis of the drum, the open ends of the legs being expanded into localized groups of holes corresponding to the banks and drilled in the drum walls or otherwise secured thereto, while the bends, c, rest in more or less upright plates, m, provided with slots, n.

Within one or both legs of each U, an inner tube is positioned, the lower end of which is open while the upper end is connected to a partition, o, within the drum, k.

In a modified form, instead of a single upper drum, two or more interconnected upper drums may in some cases be used.

The planes of the U's instead of being parallel to the axis, may in other cases be at right angles to the axis of the drum or drums, k, or any other angle desired.

When the planes of the U's are, for example, at right angles to the axis of the drum or drums, the hydraulic mean depth of the water flow may be varied by adjusting the diameter of the inner tubes in the two legs without altering the diameter of the outer legs. Thus, for example, the U-leg adjacent to the furnace where the rate of steam generation is high, may have an inner tube of small diameter or even be without an inner tube, while the leg of the U remote from the furnace may be fitted with an inner tube of large diameter.

The transverse end wall or walls of the combustion chamber may also be composed of U-Field-tube units in one or more rows.

Thus, according to one plan, the U's depend from the steam-and-water drum in groups, the legs of any one group, for example, being parallel and the groups themselves arranged fanwise to cover the relevant area.

Or as shown in Figures 8 and 9, the U-legs, r, preferably arranged with their plane at right angles to the axis of the drum to form the end walls, may be extended as at s to form the floor of the combustion chamber.

Or again, as shown in the same figures, one leg, t^1, of a U-Field-tube unit may form part of one end wall and be extended under the combustion chamber to form a floor as at u and pass on to the other leg, t^2, forming part of the other end wall.

To minimize the length of such end-wall and floor tubes exposed to maximum furnace heat, the floor tubes may, if desired, be extensions of tubes forming the side banks.

In particular, tubes of the row or rows most remote from the furnace are of low value as regards evaporation and are therefore well adapted to sustain an increased steam production if extended to form the floor of the furnace chamber.

Referring to Figure 10, a modified form of Johnson boiler having an upper and a lower drum connected by outwardly-curved steam-generating tubes is shown, according to which the lower drum is omitted and the steam-generating tubes replaced by U-Field-tube units.

The U's according to one arrangement are disposed in a manner analogous to that shown in Figures 8 and 9, but with their legs, v, outwardly curved and their bends, w, disposed as desired, while according to another arrangement, U-Field-tube units, x, preferably those most exposed to the maximum heat, pass completely round the combustion chamber in a transverse plane so as to form part of both side walls and the floor.

Both arrangements, if desired, may be used in the same boiler.

End walls also composed of U-Field-tube units may be used in conjunction with any such modified boiler.

Instead of boilers of more or less symmetrical design, as above described, according to a modified form, the steam-and-water drum is arranged at one side, with the main bank of U's extending laterally to form the crown of the combustion chamber while other U's, either straight or bent in their own plane or at an angle thereto, are disposed along or at right angles to the drum to form end and/or side walls, suitably prolonged in some cases to form the floor in addition, so that, if desired, the combustion chamber of more or less rectangular form may be completely water-walled.

The present invention is also applicable to other types of water-tube boiler embodying in their structure a steam-and-water drum and at

least one header or at least one header and one other drum connected to the steam-and-water drum.

In some forms of water-tube boiler, according to the present invention, the legs of a U may be secured to different receptacles or containers.

As compared, for example, with Yarrow or other boilers having two or more drums connected by water-tubes as heretofore constructed, it will be seen that with the U-Field-tube Yarrow-type boiler described in detail above, only one drum is required, and in the case of modern high-pressure boilers, the elimination of one or more large drums under the full pressure of the boiler and forged, it may be, out of solid metal by expensive processes, leads to a material reduction in the weight and cost of manufacture including the work involved in drilling and so forth, and also to a material reduction in the number of tube-and-drum joints.

Similar advantages arise in the case of boilers having bottom headers.

The elimination of such drums (or headers) by the use of U-Field-tube units is rendered feasible and practical by the common practice at the present day of feeding water-tube boilers with practically pure feed water so that the necessity for mud-collecting space in the lower drums or headers with their blow-down and drain connections is virtually eliminated.

Other important advantages of the invention as applied to the Yarrow type of boiler, for example, are that the replacement of a lower drum by an upright support plate carrying the ends of the U-Field-tube units, as in Figures 8 and 9, ensures greater heating surface in the same or in even less space and also a gradual reduction in the area of the gas passage through the nest of tubes, a feature that is very desirable in order to maintain a good velocity of the progressively cooled gas over the heating surface.

Further, the U's are free to expand and contract and the application of soot-blowing apparatus for action along the length of the tubes is facilitated by the absence of bottom drums.

In addition, as compared with high-pressure water-tube boilers of the drum or drum-and-header types in use at the present time, the present invention has the advantage that U's, particularly with overlapping inner tubes as shown, for example, in Figures 2, 3 and 4, assist an even and uninterrupted flow in one and that the correct direction. Furthermore, when more than one inner tube is provided in a unit, if the rate of steam generation is greater in one leg than in another, more than one source of feed-water supply is provided or is available, or even if one such inner tube should be more or less choked, circulation can continue by way of another inner tube or tubes.

It will be understood that while specific forms of the invention have been described in order to make clear its general nature, the scope of the invention as set forth in the claims appendant hereto is not restricted to such specific forms, and in particular, any other suitable form of U-Field-tube unit may be used.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. Heat-transfer apparatus comprising a U-Field-tube unit having an inner tube in each leg, the two inner tubes overlapping and the overlapping parts being flattened in cross-section.

2. Heat-transfer apparatus comprising a U-Field-tube unit having an inner tube in each leg, the two inner tubes overlapping and the overlapping parts being flattened in cross-section and secured together.

3. Heat-transfer apparatus comprising a combustion chamber and at least one container and U-Field-tube units each comprising outer and inner tubes, operatively associated therewith and individually encircling said combustion chamber.

4. Heat-transfer apparatus comprising a combustion chamber, a horizontal container of elongated form and U-Field-tube units each comprising outer and inner tubes, operatively associated with said container and forming walls of said combustion chamber, the planes of certain of the U's of said units lying parallel to the length of said container.

5. Heat-transfer apparatus comprising a U-Field-tube unit having a plurality of U's, a common junction-piece connecting the upper ends of corresponding legs of different U's and at least one forked inner tube positioned with the branches of the fork in a plurality of the U-tube legs which are so connected.

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